

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION  
International Bureau



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : <b>F26B 17/32</b>		A1	(11) International Publication Number: <b>WO 98/02700</b> (43) International Publication Date: 22 January 1998 (22.01.98)	
(21) International Application Number: <b>PCT/FI97/00385</b>			(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).	
(22) International Filing Date: 18 June 1997 (18.06.97)				
(30) Priority Data: 962853 15 July 1996 (15.07.96) FI				
(71) Applicant (for all designated States except US): KUMERA CORPORATION [FI/FI]; Kumerankatu 2, FIN-11100 Riihimäki (FI).				
(72) Inventors; and			Published With international search report.	
(75) Inventors/Applicants (for US only): TIITU, Olli [FI/FI]; Einonkuja 5, FIN-39700 Parkano (FI). KUUSISALO, Ari [FI/FI]; Kirveskatu 5, FIN-39700 Parkano (FI). LINKOMAA, Markku [FI/FI]; Järnumiehentie 16 B 1, FIN-13210 Hämeenlinna (FI).				
(74) Agent: FORSSÉN & SALOMAA OY; Yrjönkatu 30, FIN-00100 Helsinki (FI).				
(54) Title: STEAM DRYER				
(57) Abstract				
<p>The invention relates to a steam dryer, in particular for drying concentrates, which dryer comprises a drum (17), inside which a steam distributor pipe (27) and a steam tube system (18) are centrally placed, which steam tube system is formed of a plurality of steam tube groups (18<sup>1</sup>-18<sup>n</sup>) arranged around the steam distributor pipe (27) in a direction transverse to the length of the drum (17). The steam tube groups are situated in the direction of the length of the drum (17) at a distance (L<sub>2</sub>) from one another substantially over the entire length of the drum (17), and the steam tubes extend in them transversely to the radius of the drum (17) and in the radial direction of the drum concentrically at a distance from one another. The drum (17) of the steam dryer (10) is arranged to rotate by means of actuators (13, 14, 29, 15) and on support of support means (28, 16) during drying together with the steam tube system (18) situated inside said drum (17) and formed of a plurality of steam tube groups (18<sup>1</sup>-18<sup>n</sup>).</p>				

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakhstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

## Steam dryer

5

The invention relates to a steam dryer, in particular for drying concentrates, which dryer comprises a drum with a steam tube system placed inside it, said steam tube system being formed of a plurality of concentric tube ring groups placed, in a radial direction of the drum transversely to the drum, around a steam distributor pipe at a 10 distance from one another substantially over the entire length of the drum, and which steam dryer comprises feed members for the material to be dried and discharge members for the dried material, and steam supply ducts as well as condensate and gas discharge means, in which steam dryer steam is arranged to be passed into the steam tube system through the steam distributor pipe situated on the central axis 15 inside the steam dryer.

Dryer drums based on the use of steam are known from prior art, which dryers are used, among other things, for drying different concentrates. In steam dryers of this 20 type the material to be dried is placed inside a drum or equivalent and the drying steam passes in the tubes placed inside the drum. Thus, the material to be dried does not get into direct contact with steam.

Drum steam dryers are known from prior art having steam tubes, as a rule, placed 25 in a direction parallel to the axis of the drum. In some of these applications, an insulating material layer of the material to be dried formed on the surface of steam tubes has proved to be problematic. In the dryers known from prior art in which longitudinal tubes are used the degree of fullness of the apparatus is relatively low, about 10-15 % of the material to be dried of the inside volume of the drum, and they are not commonly used for drying concentrates because of their large size and 30 low efficiency.

Arrangements are also known from prior art comprising a separate rotor which constitutes a heating surface and around which there is a fixed basin that is stationary in a horizontal plane. The rotor consists of a plurality of parallel tube groups arranged along a central tube. Each tube group comprises a number of concentric tube rings, and the heat transfer medium used may be steam or a liquid. In this prior art arrangement, the steam tube system situated inside the steam dryer, carried in bearings at ends and rotating in the concentrate to be dried imposes a restriction on size and it cannot be economically increased with an increase in the amount of concentrate. In addition, in this arrangement the wear of steam tubes causes great problems when drying abrasive concentrates.

An object of the invention is to provide a steam dryer which is suitable for drying concentrates in particular and in which it is possible to utilize the steam produced elsewhere in the treatment process of concentrates.

15

Further, an object of the invention is to provide an arrangement in which wear has been eliminated or at least minimized and in which an insulating concentrate layer cannot form on the surface of steam tubes.

20 Further, an object of the arrangement in accordance with the invention is to provide an apparatus structure whose size is not restricted but can be made according to a desired concentrate amount.

With a view to achieving the objectives stated above and those that will come out later, the steam dryer according to the invention is mainly characterized in that the drum of the steam dryer and said steam tube system situated inside it and formed of a plurality of concentric tube ring groups are arranged to rotate together during drying by means of actuators on support of support means.

30 In the arrangement in accordance with the invention the steam tube system rotates with the drum, and longitudinal lifting blades situated on the inner face of the drum eliminate excessive sliding of the material on the face of the drum, so that neither

the wear of steam tubes nor the accumulation of material on the face of steam tubes cause problems, and the size of the structure is not restricted as a result of a bearing arrangement of the steam tubes or another equivalent factor.

5     In the dryer in accordance with the invention, the material to be dried is fed into the drum by means of a screw conveyor to a certain distance from an end, which facilitates drying and prevents the formation of lumps. Before starting the drying, a dry and hot initial drying material is produced inside the dryer, the wet goods to be dried being mixed with it when being fed into the dryer, so that the risk of the  
10    formation of lumps is further reduced. The dryer is provided with an overflow edge, over which the material discharges and which overflow edge at the same time ensures a sufficient delay of the material in the dryer and simultaneously a sufficient degree of fullness. In addition, the drum can be rotated in both directions in order to equalize possible wear.

15    The arrangement in accordance with the invention provides high drying efficiency because the degree of fullness can be selected so as to be as high as possible and the drum is full of steam tubes. In the dryer of the invention it is possible to use a degree of fullness of over 30 % of the material to be dried of the inside volume of  
20    the drum.

25    The drum of the steam dryer in accordance with the invention may also be in an inclined position, either downwards or upwards, to make the movement of goods more effective or to increase the delay thereof in the dryer.

30    In the following, the invention is described in more detail with reference to the figures of the accompanying drawing, to the details of which the invention is, however, in no way intended to be narrowly confined.

30    Fig. 1 schematically shows a longitudinal cross section of a steam dryer.

Fig. 2 schematically shows a section of the steam dryer in a cross direction.

Fig. 3 shows another embodiment of the steam dryer in accordance with the invention as a view corresponding to that of Fig. 2 but on a different scale.

In accordance with Figs. 1 and 2, the wet concentrate to be dried is fed into a steam dryer 10 through a feeding funnel 11 into a feed screw 12, from which it is passed into a drum 17 to a distance  $L_1$  from an inlet end 9 of the drum 17. The distance  $L_1$  is 1—2 m, preferably 1.5 m. A steam tube system 18 is placed inside the drum 17, steam being passed into said steam tube system through a tube 21 and through a rotating steam connection 22. Steam is passed into the supply tube 21 preferably from a stage of the treatment process of the concentrate where steam is produced. In the illustration of Figs. 1 and 2, the steam tube system 18 is formed of a plurality of steam tube groups  $18^1$ — $18^n$  formed of concentric steam tube rings one within the other, which steam tube groups are placed around a steam manifold 27 at a small distance  $L_2$  from one another substantially over the entire length of the drum 17.

The distance  $L_2$  is 50—300 mm, preferably 80-150 mm. Each steam tube group  $18^1$ — $18^n$  is connected to the steam manifold 27 by one or more connecting tubes 31. The tubes of the steam tube system 18 situated at the end of the drum 17 on the side of the feed screw 12 are preferably bent in a direction away from the end, thereby enabling the feed screw 12 to extend to a desired distance  $L_1$  inside the drum 17 from the inlet end 9.

The condensate produced from steam during drying is passed away along a condensate tube 23 and the exhaust gases of drying are passed along a gas duct 20 to a filter. The drum 17 and the tube system 18 rotate on support of carrier rollers 28 by means of a toothed wheel 29 and a toothed rim 15. The drive power of rotation is provided, for instance, by means of a drive motor 13 and a gear 14. The carrier rims of the drum 17 are denoted with the reference numeral 16 and axial support rollers with the reference numeral 19. Two carrier rims 16 supported on the carrier rollers 28 are placed around the drum 17 at a distance from each other. When the drum 17 and the tube system 18 rotate, the material to be dried passes through the drum 17 and, with lifting blades 30 inhibiting the material from sliding on the inner face of the drum 17, it discharges over an adjustable overflow edge 24 into a

discharge screw 25, and the dried concentrate indicated by the reference arrow 26 is obtained as a result. The inclination angle  $\alpha$  of the drum can be adjusted and it may be  $+2^\circ$  —  $-5^\circ$ , preferably  $-1^\circ$  —  $-3^\circ$ . The drying delay of the concentrate in the steam dryer 10 can be regulated by means of the inclination angle  $\alpha$ , the 5 adjustable speed of rotation and the adjustable overflow edge 24.

The illustration in Fig. 3 largely corresponds to that which has already been described above with reference to Figs. 1 and 2. The most essential difference with respect to the illustration of Fig. 2 is that in the embodiment now under consideration the steam tube groups are not formed of continuous steam tube rings of almost 10  $360^\circ$ , but, instead, in the arrangement of Fig. 3 each steam tube group consists of several sectors 18a—18h. Fig. 3 illustrates that the tubes situated in the sectors are formed of parts of a ring (sectors 18a—18d) or of parts of a straight tube (sectors 18e—18h). Each sector 18a—18h is connected to the steam manifold 27 by a 15 connecting tube 31. In the illustration of Fig. 3 the number of sectors 18a—18h is eight, in which case the angle of each sector is mainly  $45^\circ$ , but the number of the sectors may differ from the foregoing. The transfer of heat from the steam tube system to the material to be dried may be considered to be more effective and more uniform in the illustration of Fig. 3 than in the arrangement of Fig. 2, because each 20 sector is connected separately by a connecting tube to the steam manifold 27. The joint between the connecting tube 31 and the manifold 27 may be made, for instance, by welding or by some mechanical attachment.

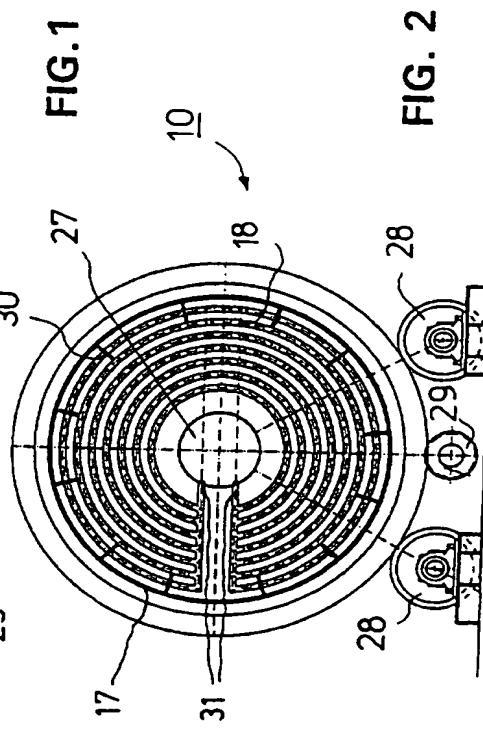
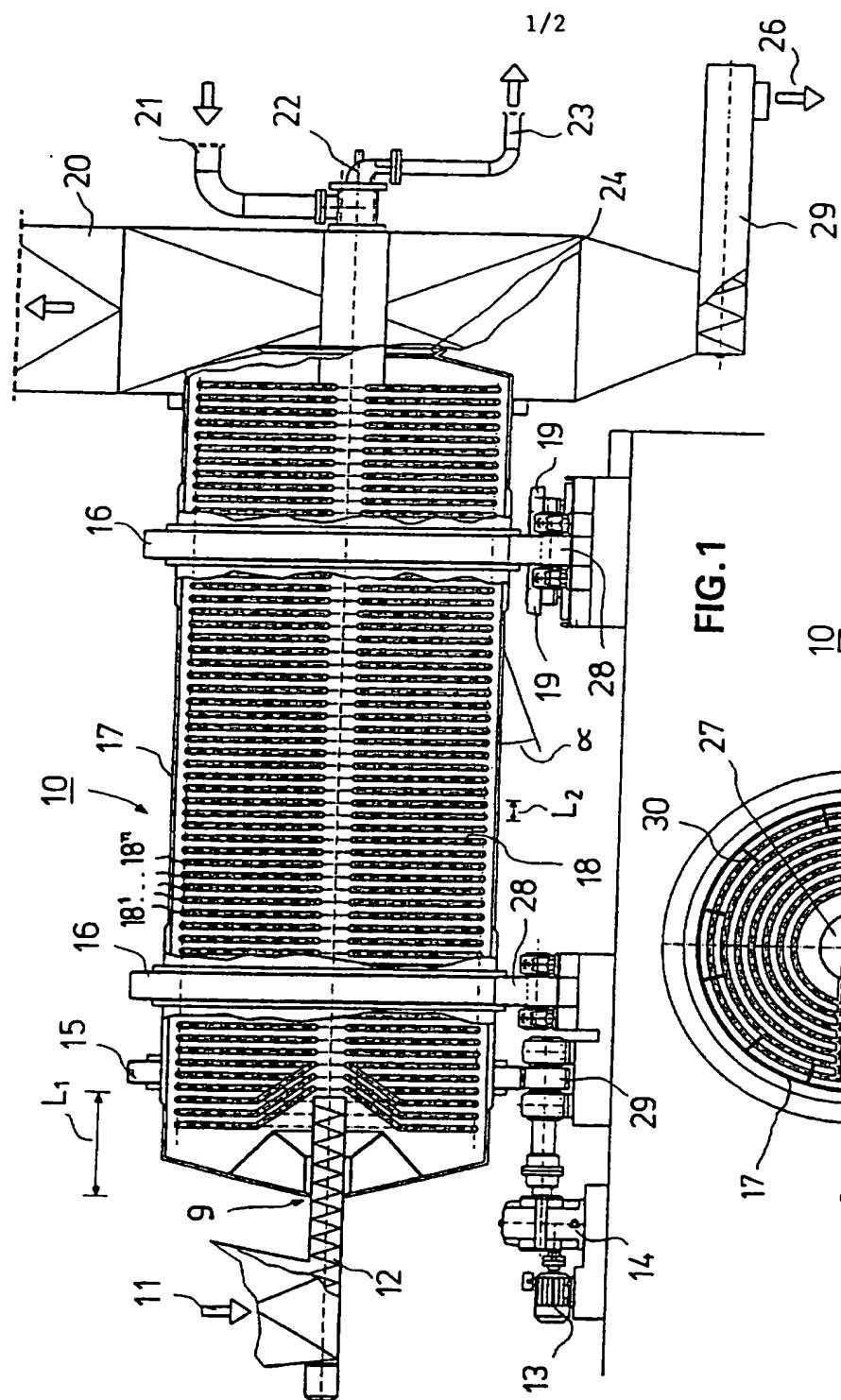
Above, the invention has been described with reference to only one preferred 25 embodiment thereof, to the details of which the invention is, however, in no way intended to be narrowly confined. Many modifications and variations are possible within the scope of the inventive idea defined in the following claims.

## Claims

1. A steam dryer, in particular for drying concentrates, which dryer comprises a drum (17), inside which a steam distributor pipe (27) and a steam tube system (18) are centrally placed, which steam tube system is formed of a plurality of steam tube groups (18<sup>1</sup>—18<sup>n</sup>) arranged around the steam distributor pipe (27) in a direction transverse to the length of the drum (17), which steam tube groups are situated in the direction of the length of the drum (17) at a distance (L<sub>2</sub>) from one another substantially over the entire length of the drum (17), and in which steam tube groups (18<sup>1</sup>—18<sup>n</sup>) the steam tubes extend mainly transversely to the radius of the drum (17) mainly concentrically at a distance from one another in the radial direction of the drum, and which steam dryer (10) comprises feed members (11,12) for the material to be dried and discharge members (24,25) for the dried material, and steam supply ducts (21,22) as well as condensate and gas discharge means (23,20), the steam in the steam dryer (10) being arranged to be passed into the steam tube system (18) through the steam distributor pipe (27) situated on the central axis inside the steam dryer (10), **characterized** in that the drum (17) of the steam dryer (10) is arranged to rotate by means of actuators (13,14,29,15) and on support of support means (28,16) during drying together with the steam tube system (18) situated inside said drum (17) and formed of a plurality of steam tube groups (18<sup>1</sup>—18<sup>n</sup>).
2. A steam dryer as claimed in claim 1, **characterized** in that said support means comprise carrier rims (16) and carrier rollers (28) fitted in connection with the drum (17) of the steam dryer (10) for supporting the drum (17) and the steam tube system (18) when they rotate.
3. A steam dryer as claimed in claim 1 or 2, **characterized** in that said actuators comprise a toothed rim (15) fitted on the outer face of the drum (17) and a toothed wheel (29), by means of which the drum (17) and the steam tube system (18) are arranged to be rotated by the drive power obtained from actuators (13,14).

4. A steam dryer as claimed in any one of the preceding claims, characterized in that the steam distributor pipe (27) is connected to a steam supply duct (21) by means of a rotating steam connection (22).
5. 5. A steam dryer as claimed in any one of the preceding claims, characterized that the steam tube groups (18<sup>1</sup>—18<sup>n</sup>) consist of several concentric steam tube rings one within the other, and that each steam tube group (18<sup>1</sup>—18<sup>n</sup>) is connected to the steam manifold (27) by one or more connecting tube (31).
- 10 6. A steam dryer as claimed in any one of claims 1—4, characterized in that the steam tube groups (18<sup>1</sup>—18<sup>n</sup>) consist of several parts of a steam tube ring or a straight tube situated one within the other in the radial direction of the drum (17) forming sectors (18a—18h) in the drum (17), and that each ring sector (18a—18h) is connected to the steam manifold (27) by at least one connecting tube (31).
- 15 7. A steam dryer as claimed in any one of the preceding claims, characterized in that the steam dryer (10) is placed in a position inclined relative to the horizontal direction, the angle ( $\alpha$ ) of inclination being +2° — -5°.
- 20 8. A steam dryer as claimed in any one of the preceding claims, characterized in that the feed members of the material to be dried comprise a feed screw (12), which is arranged to extend into the drum of the steam dryer (10) to a distance ( $L_1$ ) from the inlet end (9) of the steam dryer (10).
- 25 9. A steam dryer as claimed in any one of the preceding claims, characterized in that longitudinal lifting blades (30) are mounted on the inner face of the drum (17) of the steam dryer (10).
- 30 10. A steam dryer as claimed in any one of the preceding claims, characterized in that the members for discharging the dried material from the steam dryer (10) include an overflow edge (24) that is adjustable in position for the purpose of regulating the amount of the discharging dried material.

11. A steam dryer as claimed in any one of the preceding claims, **characterized in** that the discharge members for the dried material include a discharge screw (25).
12. A steam dryer as claimed in any one of the preceding claims, **characterized in** 5 that the speed of rotation of the steam dryer (10) can be regulated and that the steam dryer (10) can be rotated in both directions.
13. A steam dryer as claimed in any one of the preceding claims, **characterized in** that the steam used in the steam dryer (10) is steam that is produced at another stage 10 of the treatment process of the concentrate.
14. A steam dryer as claimed in any one of the preceding claims, **characterized in** that the tubes of the tube ring group of the steam tube system (18) situated on the side of the inlet end (9) of the drum (17) of the steam dryer (10) and on the side of 15 the steam distributor pipe (27) are bent in a direction away from the inlet end (9) of the drum (17).



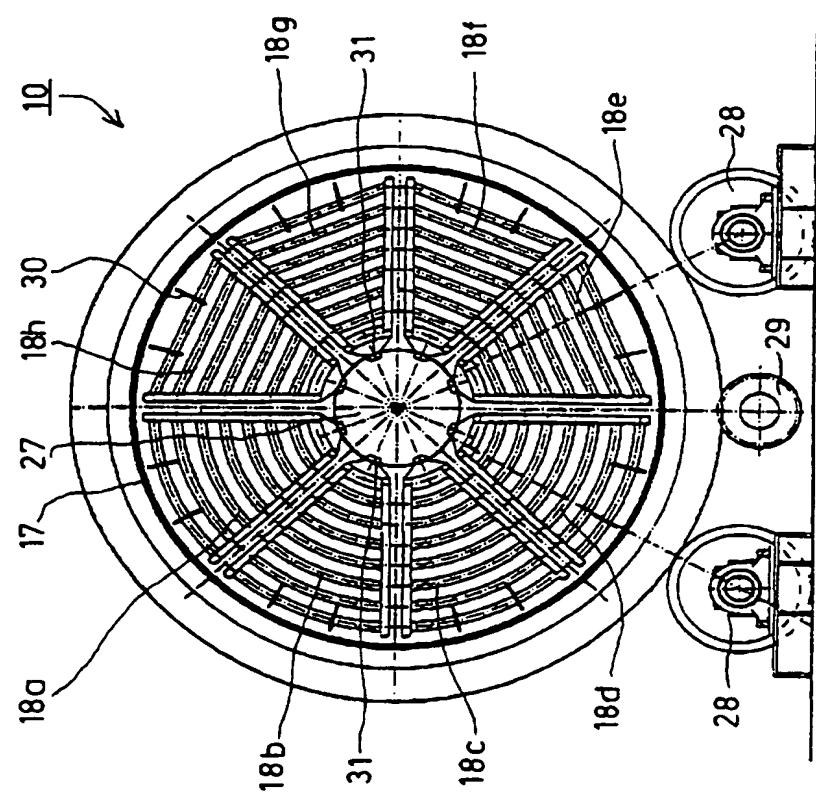


FIG. 3

1  
INTERNATIONAL SEARCH REPORTInternational application No.  
PCT/FI 97/00385

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: F26B 17/32

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: F26B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 2724639 B2 (MAMISTOV, VASILY VASILIEVITSCH ET AL), 23 August 1979 (23.08.79), column 3, line 7 - line 52 --	1-5,7-13
A	US 1510307 A (L.R. CHRISTIE), 30 Sept 1924 (30.09.24), page 1, line 41 - line 104 -- -----	1-3,7-9

 Further documents are listed in the continuation of Box C. See patent family annex.

- \* Special categories of cited documents:
- "A" document defining the general state of the art which is not considered to be of particular relevance
- "B" earlier document but published on or after the international filing date
- "C" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "D" document referring to an oral disclosure, use, exhibition or other means
- "E" document published prior to the international filing date but later than the priority date claimed
- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 October 1997	16-10-1997
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	Authorized officer  Björn Salén Telephone No. + 46 8 782 25 00

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

01/09/97

International application No.  
**PCT/FI 97/00385**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 2724639 B2	23/08/79	NONE	
US 1510307 A	30/09/24	NONE	